Claims

1. A switching power source comprising:

an inductor;

a capacitor which is provided in series with the inductor and forms an output voltage;

a switching element for controlling a current which is made to flow into the inductor based on an input voltage;

an element which clamps another terminal different from a terminal which forms the output voltage of the inductor to a predetermined potential when the switching element assumes an OFF state;

a driving circuit which drives the switching element;

a booster circuit which includes a bootstrap capacity which has one end thereof connected to an output node of the switching element and a MOSFET which has a source-drain route thereof connected between another end of the bootstrap capacity and an external power source terminal, and uses a boosted voltage as an operating voltage of the driving circuit;

a level shifting circuit which forms a switching control signal which allows the MOSFET to assume an ON state when the element is in a conductive state and allows the MOSFET to assume an OFF state when the element is not in a conductive state; and

a PWM control circuit which forms a PWM signal and

controls an operation of the switching element through the driving circuit, wherein

the MOSFET is configured to connect another source/drain region and a substrate gate such that when the MOSFET is made to assume an OFF state in response to the PWM signal, a junction diode between one source/drain region and the substrate gate is inversely directed with respect to the boosted voltage which is formed using the bootstrap capacity.

2. A switching power source according to claim 1, wherein

the switching power source includes a power source circuit which receives a high voltage corresponding to the input voltage and forms an internal voltage obtained by stepping down the high voltage, and

the internal voltage which is formed by the power source circuit is used as an operating voltage which is supplied to the booster circuit and the PWM control circuit.

3. A switching power source according to claim 1, wherein the switching element and the element are formed of an N-channel MOSFET, wherein

the MOSFET of the booster circuit is formed of a P-channel MOSFET and a substrate gate of the MOSFET is connected to the bootstrap capacity side.

4. A switching power source according to claim 1, wherein

the MOSFETs of the switching element, the element and the booster circuit are formed of an N-channel MOSFET; and

a substrate gate of the MOSFET of the booster circuit is connected to the predetermined potential terminal side.

5. A switching power source according to claim 1, wherein

the switching element is formed of an N-channel MOSFET, the element is formed of a diode; and

the MOSFET of the booster circuit is formed of a P-channel MOSFET and a substrate gate of the MOSFET is connected to the bootstrap capacity side.

6. A switching power source according to claim 4, wherein

the switching power source further includes another booster circuit which boosts an external power source which is supplied from the external power source terminal, and

the level shifting circuit allows the MOSFET to assume an ON state in response to a boosted voltage of the external power source which is formed by another booster circuit.

7. A switching power source according to claim 3, wherein

the level shifting circuit allows the MOSFET to assume an OFF state in response to a boosted voltage which is formed by the bootstrap capacity.

8. A switching power source according to claim 7, wherein

the PWM control circuit includes an error amplifier which receives a voltage signal corresponding to the output voltage and a reference voltage, a triangular wave generating circuit, a comparator which receives an output signal of the error amplifier and a triangular wave which is formed by the

triangular wave generating circuit, and a control circuit which forms a PWM signal in response to an output signal of the comparator.

9. A switching power source according to claim 8, wherein

the switching element, the element, the bootstrap capacity, the inductor and the capacitor are respectively formed of an external element; and

the MOSFET, the level shifting circuit and the PWM control circuit are formed of one semiconductor integrated circuit, and forms a PWM signal such that the output voltage assumes the predetermined voltage when the error amplifier of the PWM control circuit receives a voltage signal corresponding to the output voltage.

10. A switching power source according to claim 8, wherein

the bootstrap capacity, the inductor and the capacitor are respectively formed of an external element; and

the switching element, the element, the MOSFET, the level shifting circuit and the PWM control circuit are formed of one semiconductor integrated circuit and a PWM signal is formed such that the output voltage assumes a predetermined voltage when the error amplifier of the PWM control circuit receives a voltage signal corresponding to the output voltage.

11. A switching power source according to claim 8, wherein

the bootstrap capacity, the inductor and the capacitor are respectively formed of an external element; and

the switching element, the element, the MOSFET and the level shifting circuit are constituted of a first semiconductor integrated circuit; and

the control circuit is formed of a second semiconductor integrated circuit device, forms a PWM signal such that the output voltage assumes a predetermined voltage when an error amplifier of the PWM control circuit receives a voltage signal corresponding to the output voltage, and transmits a PWM signal to the first semiconductor integrated circuit.

12. A switching power source according to claim 1, wherein

the switching power source further includes a power source circuit which receives a high voltage corresponding to the input voltage and forms an internal voltage which is obtained by stepping down the voltage;

the bootstrap capacity, the inductor and the capacitor are respectively formed of an external element; and

the switching element, the element, the MOSFET and the level shifting circuit are constituted of a first semiconductor integrated circuit; and

the PWM control circuit is constituted of a second semiconductor integrated circuit device, and forms a PWM signal corresponding to the high voltage such that the output voltage assumes the predetermined voltage when the PWM control circuit receives a voltage signal corresponding to the output voltage and transmits a PWM signal to the first semiconductor

integrated circuit, and

the first semiconductor integrated circuit includes a voltage clamping circuit which shifts a level of the PWM signal to the internal voltage.

13. A switching power source according to claim 11, wherein the voltage clamping circuit is constituted of:

an input terminal to which the PWM signal is supplied;

an N-channel MOSFET which connects one of source-drain routes to the input terminal and allows a gate thereof to receive the supply of an internal voltage,

a current source which is provided between another source/drain route of the N-channel MOSFET and a ground potential of the circuit, and

a capacitor which is formed in parallel to the current source.

14. A switching power source according to claim 12, wherein the first semiconductor integrated circuit is formed of a third semiconductor integrated circuit which constitutes a switching element, a fourth semiconductor integrated circuit which constitutes the element, and a fifth semiconductor integrated circuit which constitutes the MOSFET and the level shifting circuit.

15. A semiconductor integrated circuit comprising:

a first terminal of a switching element which controls a current for forming an output voltage by stepping down an

input voltage for allowing the current to flow in the switching element;

a second terminal to which another end of a bootstrap capacity which has one end thereof connected to the first terminal is connected;

a MOSFET which has a source/drain route thereof connected between an external power source terminal and the second terminal; and

a driving circuit which drives the switching element, wherein

the bootstrap capacity and the MOSFET constitute a booster circuit for generating a boosted voltage for driving the the switching element, and

the MOSFET is configured to connect another source/drain region and a substrate gate such that when the MOSFET is made to assume an OFF state, a junction diode between one source/drain region and the substrate gate is inversely directed with respect to the boosted voltage which is formed using the bootstrap capacity.

16. A semiconductor integrated circuit according to claim 15, wherein

the bootstrap capacity is provided outside the semiconductor integrated circuit.

17. A semiconductor integrated circuit according to claim 16, wherein

the current is a current which is made to flow into an inductor from the input voltage for forming the output voltage by the inductor and a capacitor which is provided in series with the inductor.

18. A semiconductor integrated circuit according to claim 17, wherein

the switching element is formed of an N-channel MOSFET, and

a MOSFET of the booster circuit is formed of a P-channel MOSFET and has a substrate gate thereof connected to the bootstrap capacity side.

19. A semiconductor integrated circuit according to claim 17, wherein

the switching element and the MOSFET of the booster circuit are formed of an N-channel MOSFET, and

a substrate gate of the MOSFET of the booster circuit is connected to the terminal side.

20. A semiconductor integrated circuit according to claim 17, wherein

the semiconductor integrated circuit further includes an element which clamps another terminal of the inductor different from a terminal of the inductor which forms the output voltage of the inductor to a predetermined potential when the switching element assumes an OFF state,

the element is formed on a first semiconductor substrate,

the switching element is formed on a second semiconductor substrate,

the driving circuit is a circuit which performs an ON and OFF control of the switching element and the element upon receiving a control signal which allows an output voltage to assume a predetermined voltage and is formed on a third semiconductor substrate, and

the first semiconductor substrate, the second semiconductor substrate and the third semiconductor substrate are sealed in one package.

21. A semiconductor integrated circuit according to claim 20, wherein

the control signal is formed of a PWM signal.

22. A semiconductor integrated circuit according to claim 21, wherein

the driving circuit includes a level shifting circuit which forms a switching control signal which allows a MOSFET to assume an ON state when the element is in an ON state and allows a MOSFET to assume an OFF state when the element is in an OFF state.

23. A semiconductor integrated circuit according to claim 22, wherein

the PWM signal is a signal which is generated by an error amplifier which receives a voltage signal corresponding to the output voltage and a reference voltage, a triangular wave

generating circuit, a comparator which receives an output signal of the error amplifier and a triangular wave which is formed by the triangular wave generating circuit, and a control circuit which receives an output signal of the comparator.

24. A semiconductor integrated circuit according to claim 23, wherein

the semiconductor integrated circuit further includes a power source circuit which receives a high voltage corresponding to the input voltage and forms an internal voltage which is obtained by stepping down the voltage, and

a voltage clamping circuit which shifts a level of the PWM signal to the internal voltage is formed in the semiconductor integrated circuit.

25. A semiconductor integrated circuit according to claim 24, wherein

the voltage clamping circuit is constituted of:

an input terminal to which the PWM signal is supplied;

an N-channel MOSFET which connects one of source-drain routes to the input terminal and allows a gate thereof to receive the supply of an internal voltage,

a current source which is provided between another source-drain route of the N-channel MOSFET and a ground potential of the circuit, and

a capacitor which is formed in parallel to the current source.

26. A semiconductor integrated circuit according to claim 20, wherein

the driving circuit includes a level shifting circuit which is formed of:

a first circuit which is operated with the first amplitude;

a second circuit which is formed of a MOSFET which receives a signal outputted from the first circuit, and a resistance which is connected in series with the MOSFET between the MOSFET and another end of the bootstrap capacity; and

a third circuit which receives a signal outputted from a node to which the MOSFET and the resistance of the second circuit are connected and uses a voltage at another end of the bootstrap capacity as a power source, and

the driving circuit generates a control signal whose level is shifted for performing an ON and OFF control of the first switching element by discriminating a signal which is outputted from the node whose voltage level is changed by changing over ON and OFF states of the MOSFET along with a high level and a low level of the output of the first circuit in accordance with a logic threshold value of the third circuit.